Strategic Approaches to Data Science & Open Science at NLM & NIH

Implementing FAIR Data for People & Machines Symposium
September 11, 2019

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Director, Office of Strategic Initiatives
Associate Director, National Library of Medicine, NIH
Data Science is a **scientific & methodologic approach** to understanding data (Just as molecular biology is a scientific & methodologic approach to understanding disease)
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(Just as molecular biology is a scientific & methodologic approach to understanding disease)

**New tools for new insights**
“New directions in science are launched by new tools much more often than by new concepts.”

Freeman Dyson
_Imagined Worlds_
(1997)
Harvard University Press
Open Science

Open Science is a new paradigm, a different way of doing science in which the products and processes of research (research objects) are broadly available & usable.
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Open Science is a **new paradigm**, a different way of doing science in which the **products and processes of research** (research objects) are broadly **available & usable**

Best practices for open science abide by **FAIR principles**
“...paradigm changes do cause scientists to see the world of their research engagements differently.”

Thomas Kuhn
_The Structure of Scientific Revolutions_
(1962)
University of Chicago Press
DS + OS = new tools and new paradigm

Data Science
- math & statistics
- computer science & coding
- subject matter expertise

Open Science
- Findable
- Accessible
- Interoperable
- Reusable
DS & OS are very powerful when paired

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U.S. National Library of Medicine
NIH has paired DS & OS to tackle significant biomedical research questions through several open, large scale, data-centric, digital initiatives.
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The Human Connectome Project

NIH The Common Fund

ECHO Environmental Influences on Child Health Outcomes

NIH HUMAN MICROBIOME PROJECT

The Human Genome Project

ADNI Alzheimer’s Disease Neuroimaging Initiative

CANCER MOONSHOT

FlyBase MG1

ZFIN Saccharomyces Genome Database

WormBase

All of Us The Future of Health Begins With You

NIH Research to be Even MORE data-centric & open
Societal Expectations

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Technical Capabilities
Societal Expectations

NIH Research to be Even MORE data-centric & open

Technical Capabilities

Scientific Opportunities
Societal Expectations

Policy & Legislative Directives

NIH Research to be Even MORE data-centric & open

Technical Capabilities

Scientific Opportunities
The National Library of Medicine lives at the intersection of data science & open science
National Library of Medicine

• An Institute of the NIH (1968)
  – Lead, conduct, and support research and training in biomedical:
    • Information science
    • Informatics
    • Data science
National Library of Medicine

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    • Information science
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    • Data science

• The world’s largest biomedical library (1836)
  – Create & host major resources, tools, & services for literature, data, standards, & more
    • Send > 115 terabytes of data to > 5 million users daily
    • Receive > 15 terabytes of data from > 3,000 users daily
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    • Send > 115 terabytes of data to > 5 million users daily
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  – Facilitate open science & scholarship by making digital research objects:
    • Findable, Accessible, Interoperable, & Reusable (FAIR)
    • As well as Attributable & Sustainable
Now that the table is set, what’s on the menu?
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NLM Strategic Plan
Now that the table is set, what’s on the menu?

NLM Strategic Plan

NIH Strategic Plan for Data Science
Innovate, build, & sustain an open digital ecosystem for health info, science, & scholarship
Imp. Goal 1 – Connect & Enhance Resources

- Aligning curation across data & literature
- Universal Dataset Metadata Model Initiative
- Integration of select digital resources
- NLM Labs projects - indexing & linking info
- Blue Ribbon Panel Review of Intramural Research Programs
- Recruitment of Intramural Research Program Scientific Director, three investigators, & staff
- NSF-NLM data science MOU
- Data science research RFI
- Data Science Drivers Workshop & report
- At-scale computational curation FOA
- Research Reproducibility Workshop & report
- Ethnographic study of reproducibility
- Recruitment of 2 DSOS staff in OD
- NASEM study of value assessment for OS
- NASEM roundtable on incentives for OS
- Assessment of IT – 5 aspects & teams
- Assessment of NLM portfolio of offerings
- Assessment of NIH CDE Repository
- Assessment of data center & cloud Use
- Assessment of trans-NLM central functions
- Assessment & comparison of indexing methods
- Assessment of workspace
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Imp. Goal 1 – Innovate, Expand, & Enhance Research

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Innovate, build, & sustain an open digital ecosystem for health info, science, & scholarship

Optimize user experience with, and use of, NLM digital resources
Imp. Goal 2 – Optimize User Experience

- Assessment of tools to evaluate resources
- Assessment of comparative web metrics
- Audit & assessment of outreach efforts
- User experience/development initiatives
- Reorganized and enhanced outreach, engagement, & training on resource use
- Personal health libraries FOA
- Health information resources to reduce health disparities FOA
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Optimize user experience with, and use of, NLM digital resources

Assure a data-savvy biomedical workforce and a data-ready public
Imp. Goal 3 – Data Science Research Training

- Expand extramural predoctoral & postdoctoral data science research training
- Research reproducibility training of intramural scientists
- Data science core skills analysis & report
- Comprehensive analysis & report on state of data science training in biomedicine
- Data science skills for librarian workforce workshop & report
- Data science assessment and training of all NLM staff

- Data science & open science needs assessment of NIH extramural staff
- Establish trans-NIH coordination on NIH staff training in DSOS
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- Increase partnerships with minority serving institutions
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- Expand summer research training of high school and undergrad students
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NIH Strategic Plan for Data Science – ODSS & SDC
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- Support Highly Efficient and Effective Data **Infrastructure** for Biomedical Research
- Promote the Modernization of the Research Data Resources **Ecosystem**
- Support the Development and Dissemination of Advanced Management, Analytics, and Visualization **Tools**
- Enhance **Workforce** Development for Biomedical Data Science
- Enact Appropriate Policies to Promote Stewardship and **Sustainability**
Key Objective: FAIR data sharing for NIH research
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• Provide FAIR-enabled, open access for all datasets that underlie publications resulting from NIH-funded research
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• Identify key characteristics of repositories housing those data
  • Initial key characteristics identified by BMIC Subgroup
  • Government-wide RFI for public comment on characteristics currently being drafted
Sharing Publication-Related Data

NIH strongly encourages use of open domain-specific repositories as a first choice

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Options of scaled implementation for sharing datasets
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Datasets up to 2 GB

**PubMed Central**
- PMC stores publication-related supplemental materials and datasets directly associated publications. Up to 2 GB.
- Generate Unique Identifiers for the stored supplementary materials and datasets.

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Datasets up to 20* GB

**Use of commercial and non-profit repositories**
- Assign Unique Identifiers to datasets associated with publications and link to PubMed
- Store and manage datasets associated with publication, up to 20* GB.
# Sharing Publication-Related Data

NIH strongly encourages use of open domain-specific repositories as a first choice


## Options of scaled implementation for sharing datasets

<table>
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<tr>
<th>Dataset Size</th>
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<td><strong>High Priority Datasets PBs</strong></td>
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<td>- Store and manage large scale, high priority NIH datasets (Partnership with STRIDES)</td>
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<td>- Assign Unique Identifiers, implement authentication, authorization &amp; access control</td>
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STRIDES

Science & Tech Research Infrastructure for Discovery, Experimentation & Sustainability
STRIDES

Science & Tech Research Infrastructure for Discovery, Experimentation & Sustainability

- Agreements with
  - Google Cloud
  - Amazon Web Services
  - Additional partnerships anticipated

- Other Transaction Authority used
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  • Google Cloud
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• Other Transaction Authority used

• Benefits to NIH-supported Investigators
  – Discounted rates on cloud services
  – Access to engineering, consulting, and other professional services from cloud service provider partners
  – Access to cloud training programs (standard & custom)
Examples of datasets moving to STRIDES-clouds

- NHLBI Framingham Heart Study
- All of Us Research Program
- NCI Genomic Data Commons
- NLM Sequence Read Archive
- NHLBI Trans-Omics for Precision Medicine (TOPMed) Program
- NCI Proteomics Data Commons and Imaging Data Commons
- NIMH Data Archive
- Gabriella Miller Kids First Pediatric Research Program
- Transformative CryoEM Program Data
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Implementation of NIH SP for DS (so far)

Data Infrastructure
Enabling FAIR

- Establishing **partnerships** with commercial clouds
- Moving High value **datasets to clouds**
- Training & outreach on clouds across ICs

Modernize the Data Ecosystem
Enabling data sharing across ICs and grantees

- Conducting **inventory & gap analysis** of current large scale data resources
- **FHIR initiatives** for sharing phenotypic data & tool development
- Implementing NIH-wide system for user authentication & authorization

Data Management, Tools and Analytics

- Linking **datasets to publications** in PubMed Central
- Identifying key **characteristics of data repositories**
- NLM FOA on Curation at Scale
- **NIH FOAs to support Trans-NIH Databases & Knowledgebases** coming soon!
Implementation of NIH SP for DS (so far)

**Workforce Development**
Infusing biomedical research with new skills

- Coding-it-forward; 10 **undergraduate fellows** placed in ICs for summer 2019
- 13 **Masters fellows** placed in intramural laboratories for summer 2019
- Quantitative and computational skills language for **training FOAs** developed & being disseminated

**Stewardship & Sustainability**
Policy and Implementation go ‘hand-in-hand’

- RFI on key provisions for data management and sharing policy
- **Draft policy** target date is summer 2019
- **Final policy** by ~ December 2019
Needed to Realize the Promise of DS/OS
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• **Incentives** – Establish & align incentives to promote open science practices (e.g., sharing data, adopting standards, using appropriate repositories)
  – Strategically align incentives across entire ecosystem to maximize impact
  – Likely best done domain-by-domain
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- **At-Scale Curation & Provenance** – Rapid increase in number of DROs and the need to find, associate, and monitor their versions is outstripping the ability to apply consistent, useful metadata to them. Move from applying metadata to having DROs imply their metadata
  - Move from search to learning, and from learning to awareness
  - Draw from artificial intelligence, blockchain, etc.
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• **Sustainability** – Assure ROI by assessing the value of particular investments in the ecosystem (e.g., in infrastructure, data acquisition, preservation, policy changes, etc.)
  – Rigorous cost vs benefit analyses
  – Metrics & models
NLM Office of Strategic Initiatives
Data Science & Open Science Team

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Data Science & Open Science Librarian

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